Executive Summary

Objective
This project was conducted to support AAA Washington in forecasting monthly emergency road service (ERS) call volumes. The organization sought to improve its budgeting and resource planning by predicting demand more accurately using historical data and environmental indicators.

The analysis was structured in three phases:

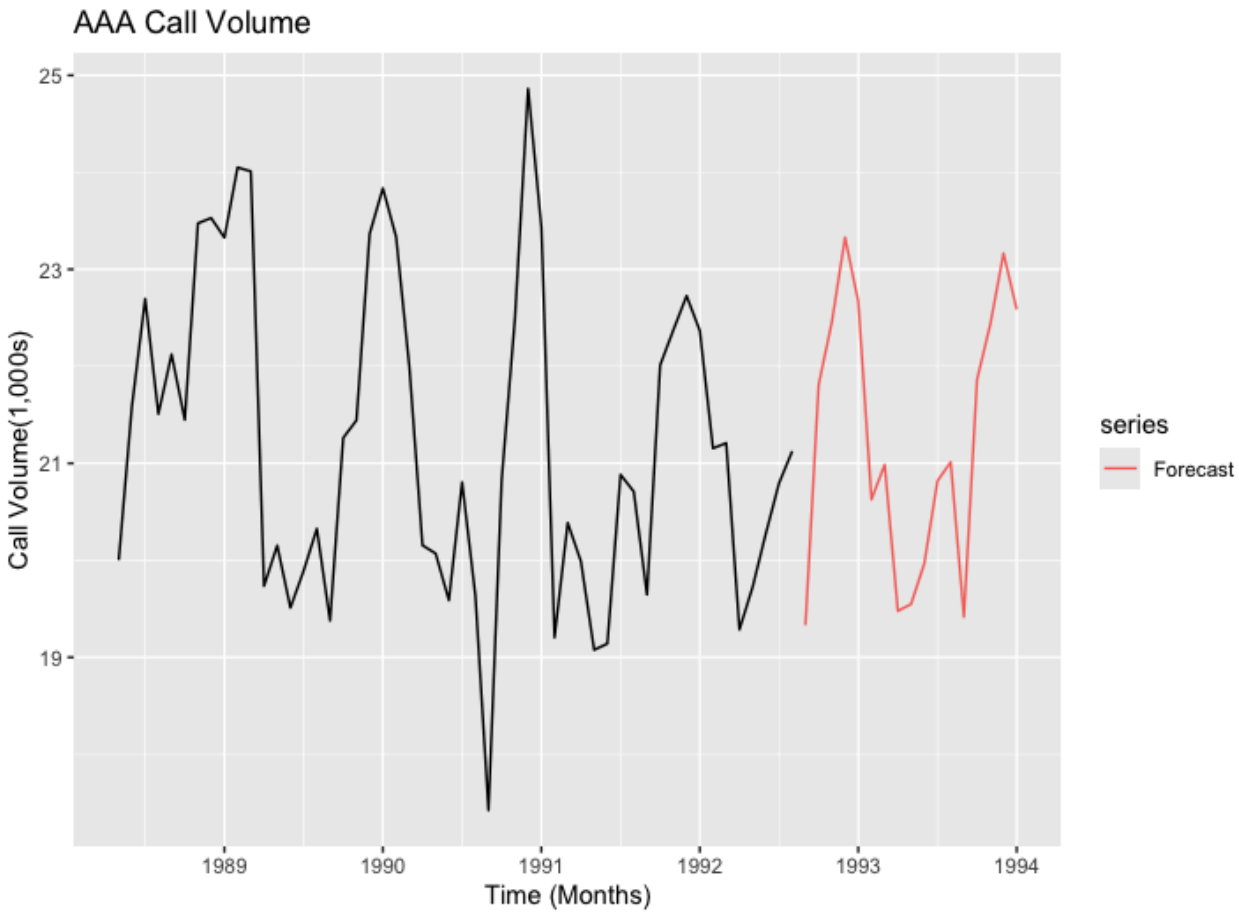
Phase 1: Exploratory Time Series Analysis
Initial visualization of call volume data from May 1988 to August 1992 revealed strong seasonality, with lower call volumes during warmer months and higher demand during colder months. A moderate upward trend and some autocorrelation patterns were also observed. Based on these insights, we applied time series decomposition to confirm the seasonal and irregular components.

Phase 2: Box-Jenkins Modeling (SARIMA)
To capture temporal dependencies and seasonality more rigorously, several Seasonal ARIMA (SARIMA) models were tested. Six candidate models were evaluated and validated where the best performing model was: SARIMA(1,0,0) × $(1,1,0)_{12}$. This model achieved a MAPE of 2.51% on validation data and showed minimal error variance and strong robustness, outperforming all other alternatives.

Phase 3: Time Series Regression with Exogenous Variables
To further enhance accuracy, we incorporated average monthly temperature and Washington State unemployment rate as external predictors. A transformed temperature variable, measuring deviation from the optimal 60°F, showed a strong positive linear relationship with ERS call volume. Cross-correlation analysis indicated that unemployment rates lead service call volume by 11 months, making them a viable economic indicator. A multiple regression model including the temperature deviation and a 11-month lagged unemployment rate achieved a MAPE of 3.58% on validation. This model explained a meaningful portion of the variability in calls about 57%, though residual analysis revealed some autocorrelation, suggesting potential benefit from integrating ARIMA components in future iterations.

Recommendation
Based on model performance and interpretability, we recommend using the SARIMA$(1,0,0)(1,1,0)_{12}$ model for short- to medium-term forecasting. For enhanced insight and longer-term forecasting, the regression model combining temperature deviation and lagged unemployment rate is also valuable.

We advise AAA Washington to update and retrain these models quarterly and consider adding other weather or traffic-related predictors to improve forecasting precision further.


AAA Call Volume
25
23
21
19
Call Volume(1,000s)
1989
1990
1991
1992
1993
1994
Time (Months)
series
Forecast